TECHNICAL report

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Air Conditioner Requirements Validation Review of Decentralized Automated Service Support System (DAS-3)

by
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Report Date
May 1992

United States Army
Belvoir Research, Development and Engineering Center
Fort Belvoir, Virginia 22060-5606

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13. ABSTRACT (*Maximum 200 words*)

This report assesses the tactical electric power and cooling requirements of the Decentralized Automated Service Support System, or DAS-3 (AN/MYQ-4A), for the "Air Conditioner Requirements Review Program."

14. SUBJECT TERMS

Systems Assessment Model (SAM)
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May 1992

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Section I

Background

The U. S. Army's Troop Support Command (TROSCOM) and Training and Doctrine Command (TRADOC) initiated the "Air Conditioner Requirements Review Program" to establish requirements for a new generation of environmental control equipment. TRADOC's Ordnance School; TROSCOM's Special Programs Management Offices; and Belvoir Research, Development, and Engineering Center (BRDEC), Systems Assessment Team were the program's primary participants. The Systems Assessment Team was directed to assess the electric power and cooling requirements of selected Army systems. To assist in this effort, a Special Sample Data Collection (SSDC) Project was established under the auspices of the TROSCOM Sample Data Collection Program. The SSDC Project inventories each system, paves the way for the assessment, and conducts operator interviews regarding the effectiveness of existing electric power and cooling equipment. Systems to be assessed include: DAS-3, MSE, TACMIS, FAADS, SICPS, and Patriot.

Section II

Approach

It is necessary to account for electrical power demand when determining the cooling load of a system. This process involves three steps:

First, all power consuming equipment in the system's shelter must be inventoried. This includes collecting the manufacturer's nameplate data and inspecting manuals for each item.

Second, the system's power consumption must be measured while equipment items, groups, and the entire system are powered-up and powered-down. From this data, the power demand of each piece of equipment and a predicted maximum system power demand can be derived. This technique includes power conditioner losses with the supported equipment's power demand.

Finally, the shelter's thermal characteristics and personnel and tactical requirements must be entered into the Shelter Systems Assessment Model (SAM). The computer model can then determine cooling loads and Environmental Control Unit (ECU) suitability under hypothetical ambient conditions. When test conditions allow, the ECU needs should be validated using temperature data taken during the test and by interviewing experienced system operators.

Section III

System Description

DAS-3 is designed to process data for personnel, medical and financial functions at the division, corps or theater levels of command. DAS-3:

- Reduces, manipulates and summarizes data.
- Generates reports and historical files.
- Processes interactive or batch transactions (through an electronic interface or recording media) with other management information systems.

The DAS-3 system provides tactical data processing within an operational area. It is housed in a single 5-ton XM971 semitrailer van (see Figure 1). Field power is provided by a 60 kW, 60 Hz trailer-mounted generator set (AN/MJQ-12). Four 18,000 BTUH vertical air conditioners, Line Item Number A2445 (CH-620-2), provide cooling.

DAS-3's electronic equipment includes communications, printing, and data recording and processing (see Appendix). Four soldiers operate the system.

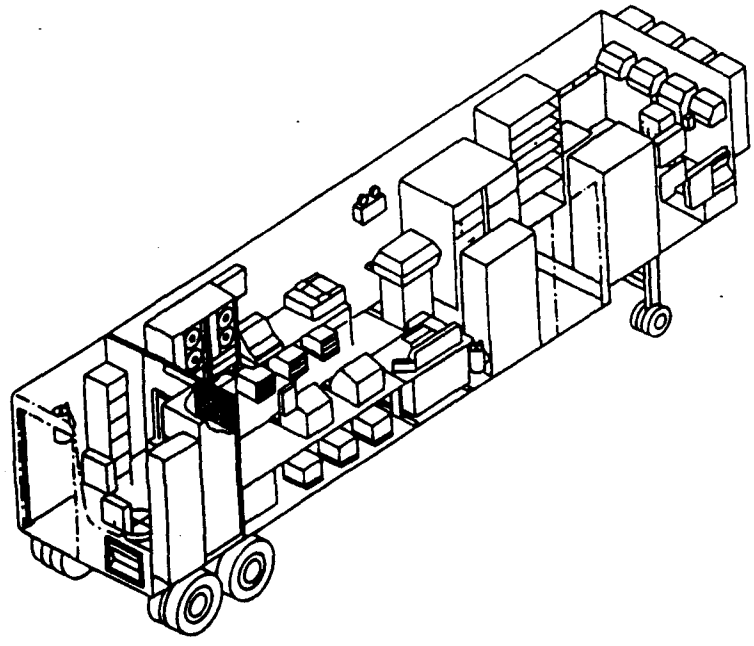

Figure 1. DAS-3 Shelter Diagram

Section IV

Discussion

An inventory of DAS-3 was performed (see page 4 of the Appendix), and each piece of power consuming equipment was listed as a column heading on the Power Measurement Load Configuration form (see Figure 2 of Appendix). This form documents the switch position for each equipment item at each step of the test sequence. The test began with all equipment turned off. The test team took power consumption readings at the power source while operators switched on various groupings of equipment in sequence. The power readings were entered in the Power Generator Performance form (see Figure 3 of Appendix). This form records the load on each phase of the generator for each step in the test sequence.

The power consumed by each item, including associated power conditioning losses (see Table 1), is derived from the change in total power as the item is switched on. The power consumption data listed on Table 1 is grouped into several subcategories.

The first category, "Total Internal Power Demand Measured in Operational Mode," refers to equipment that was tested at its full operational capacity. The second category, "Measured Power Demand in Stand-By Mode," refers to equipment for which test conditions prevented maximum load operation. For example, a computer disk drive may not run unless certain software is available. Those subtotals are then added to achieve "Total Measured Power Demand Internal Load," which is the electric power which the ECU capacity must compensate for to maintain the desired internal temperature. The final total, "Total Estimated Generator Load," includes the electric load which does not contribute to the cooling requirement.

Power consuming items and their respective power demand were used as input for eight computer runs of SAM (see Figures 2 and 3). Cooling loads for internal temperatures of both 80°F and 90°F are considered. The equipment requires 80°F to operate continuously while Human Factors considerations require a maximum of 90°F. Internal humidity was limited to 60%. Desert conditions (environment 1, AR 70-38), tropic conditions (environment 4), and equipment power use of 5 and 10 kW were analyzed. Assumptions used in the computer analysis are found in Table 2.

Table 1. DAS-3 Equipment Power Demands

Nomenclature	(count)	Model Number	Power Demand (watts)
Light, Fluorescent ICP	(24)	BR-2009 (30W)	720
Processing Unit, Data		CP-1435	896 *
Disk Memory Unit	(6)	MV-705	2170
Keyboard Display	(3)	MX-10173	306
Converter, Frequency		CV-3661A	100
Modem****	(2)	MD-1149	
Converter****	(2)	CV-3787	
Modem****		MD-1150	
Converter****		CV-3788	1813
Isolator Unit****		—	(Total)
Total Measured Power Demand in Operational Mode			***5005***
Magnetic Tape Unit***	(2)	TW-430	115 **
Total Measured Power Demand in Stand-By Mode			***115***
Total Measured Power Demand Internal Load			***5.12 kW***
Cleaner, Magnet I		MX-10172	
Card Punch, Reader I***		R-0526A	3kW total
Line Printer		RP-309	estimated for
Printer Assembly		TT-804	items not present
Dual Diskette Drive***		MV-857	or not operational
Humidifier***		6066NIO	
Total Internal Load, Estimated + Measured			***8.12 kW***
Environmental Control Unit	(4)	F18T-2	20.60 kW
Total Generator Load as Measured			***25.72 kW***
Total Estimated Generator Load			***28.72 kW***

* Operated in test mode

** Operated in stand-by mode

***Several equipment items were inoperative or removed for maintenance:

****A group of equipment operated (without individual switches) from a breaker was turned on and off simultaneously. Only total power demand could be calculated.

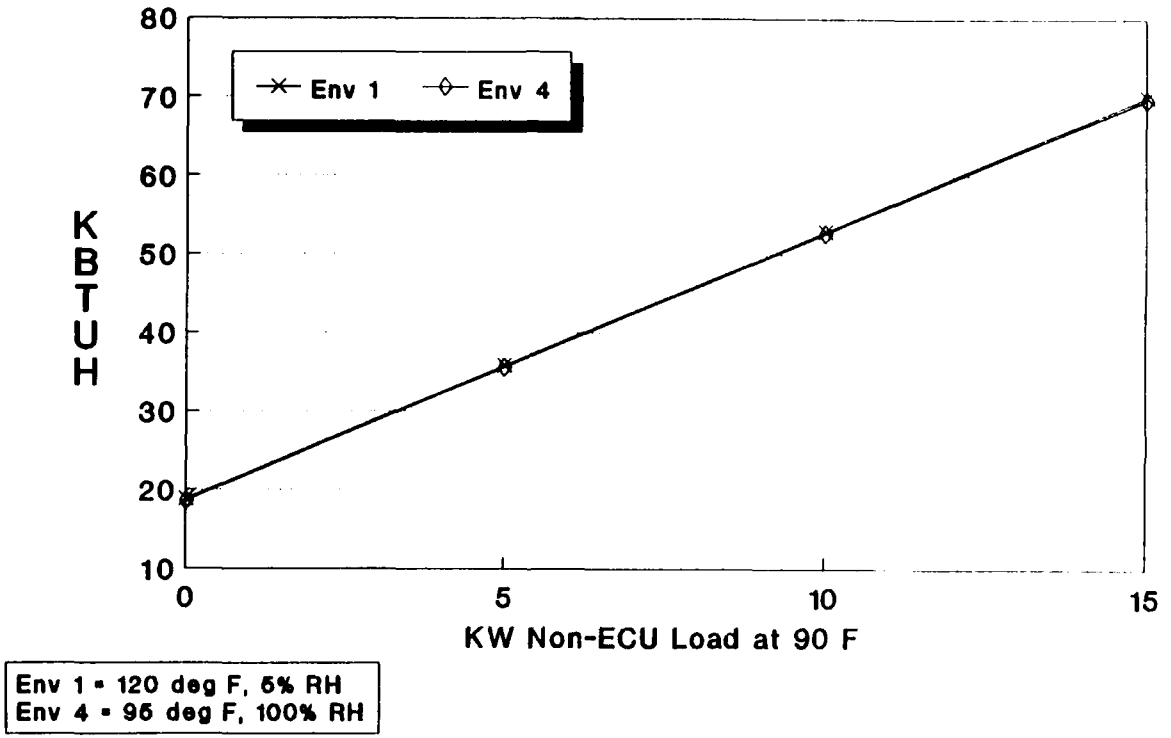

Figure 2. Cooling Requirements, 90°F Internal

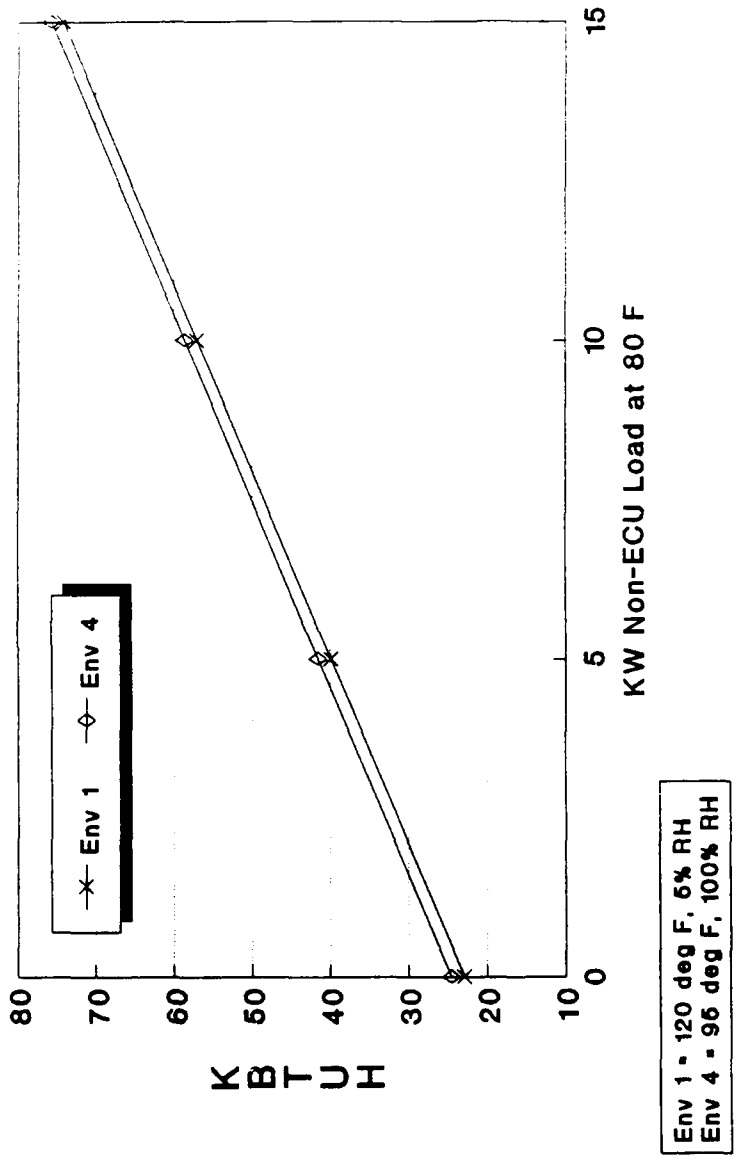

Figure 3. Cooling Requirements, 80°F Internal

Table 2. SAM Model Data

SHELTER SYSTEM ASSESSMENT MODEL
HVAC, POWER, AND WEIGHT REQUIREMENTS

Run Parameters	Calculation Details	Totals
Run Config. Environ. 1 DAS-3 1 ENV4 Structure: XM971E1 Weight: 13110.0 lbs Other Settings AC Util. Conv. In. No CBR Total CFM: 80.0 Min. Interior Temp. (°F) Max. Interior Temp. 90. (°F)	BTU/Equip. : 51195. (0 for AC, /Shelter: 8882. (0 for Heat) /Sensible & latent heat due to ventilation and personnel: 9644. KW/ a) Heat: 0.00 b) AC: 20.78 c) Equip: 15.00 d) Max(Heat,AC): 20.78 e) Max(MaxHeat,MaxAC,MaxEqp): 24.94 Note: "e" accounts for the highest individual power consumer regardless of usage rate and includes the startup factor. Personnel Wt: 1068 lbs AC Weight: lbs Equip Wt: 0.0 lbs Generator Wt: lbs	BTU/hr 69721.0 Adjusted Power (KW) [Max(c+d,e)] Total Wt. Incl. Struc. (LBS)

CONFIGURATION DESCRIPTIONS

CONFIGURATION: DAS-3 1

Config description: DAS-3 with dummy load
It is housed in a: XM971E1

PERSONNEL LOADING

QTY	SENSIBLE LOAD (BTU/hr)	LATENT LOAD (BTU/hr)	VENTILATION (CFM/hr)	WEIGHT/PERSON (lb)
4	315.00	325.00	20	267

ENVIRONMENT CHARACTERISTICS

ENVIRONMENT NAME	TEMPERATURE OUTSIDE (°F)	HUMIDITY OUTSIDE (%)	WIND SPEED (mph)	SOLAR LOAD (BTU/HR/ft²)	GROUND TEMPERATURE (°F)
ENV4	95.0	100.0	8.9	307.0	130.0
ENV1	120.0	5.0	8.9	231.0	145.0

DATA FOR STRUCTURES

NAME		TOP	SIDE	END	BOTTOM
XM971E1	Surface area (ft²):	283.33	582.77	124.34	283.33
	U-factor (BTU/hr/ft²/°F):	0.23	0.23	0.23	0.23
	Solar Absorb.(BTU/hr/ft²):	0.70	0.70	0.70	0.70
	Angle with horizontal:	0.00	90.00	90.00	180.00
	Area of Uninsulated Penetration by Conduits(ft²):	0.00	0.00	0.00	0.00

Weight (lbs): 13110.0 Heat Capacitance (BTU/lb/°F): 1.

Section V
Findings

The DAS-3 power demand, with all available equipment operating, measured 25.72 kW, including 20.6 kW for ECUs and 5.12 kW for equipment. In this configuration, a 30 kW generator set and three of the 18,000 BTUH air conditioners would provide more than the required power and cooling for DAS-3's electronic equipment even with an 80°F limit. When an additional 3 kW load is added to account for equipment not available for measurement at the time of this test, the fourth ECU will be needed to maintain 80°F.

Operator interviews confirm that the generator set and air conditioners provided with the DAS-3 are appropriate for mission operations.

Appendix

SR90-158

November 8,1990

Special Report

Air Conditioner Requirements Review
Power Consuming Equipment Inventory
Decentralized ADPE Service Support
DAS3

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SPECIAL REPORT
AIR CONDITIONER REQUIREMENTS REVIEW

DAS3 ASSESSMENT

INTRODUCTION

This special report on field data collected has been prepared to provide Belvoir Research, Development and Engineering (RD & E) Center's Systems Assessment Team selected information about DAS3, an Army system designated by U.S. Army Ordnance Center and School (Letter, ATSL-CD-MS, Subject: Air Conditioner Requirements Review, dated 19 September 1990) as a system best suited to provide input to an air conditioner requirements analysis.

PROGRAM OVERVIEW

The collected information from each of nine systems will be summarized by the Systems Assessment Team in a concise, meaningful form, and conveyed to the Training and Doctrine Command (TRADOC) Air Conditioner Requirements Review (ACRR) Team at the U. S. Army Ordnance Center and School for consideration as the team addresses and recommends attributes for a new standard family of tactical air conditioners.

The specified systems are:

TACFIRE	-Direction Center, Artillery
FAADS	-Forward Area Air Defense System
JTIDS	-Joint Tactical Information Distribution System
SICPS	-Standardized Integrated Command Post System
MSE	-Mobile Subscriber System
PATRIOT	-Air Defense Missile System
DAS3	-Decentralized Automated Service Support System
HAWK	-Air Defense Missile System
TACMIS	-CTAS-2 Corps/Theater ADP Service Center)

Coordination to gain access to the target systems is done at command levels. Local schedules and task interpretation at the owning unit is done by COBRO representatives on site.

DATA COLLECTION INFRASTRUCTURE

The data collection phase of the ACRR program utilizes Belvoir's Tactical Assessment of Power (TAP) Sample Data Collection (SDC) Program. The TAP program was selected to support the ACRR program because all of the field data can be obtained in similar fashion and without adding additional people.

TAP is supported in the field using the contracted support infrastructure for SDC. COBRO Corporation provides the support to TAP and to ACRR through its offices at Fort Belvoir, Fort Bragg, Fort Hood, and others, depending upon where the target systems can be located.

DATA OBJECTIVES

The collection is focussed on the equipment listed under Program Overview. The purpose is to develop detailed data on tactical power consumers, tactical shelters, tactical air conditioners mounted on the tactical shelters, shelterized system crew staffing, system environmental capability, system operating profiles, and crew training and experience.

COLLECTION METHODOLOGY

Data are collected on site by a team of people organized to perform a subsystem inventory, conduct a controlled, power-up procedure, measure operating and environmental parameters, and debrief operators about their training on the system, their field experience with the system, and the system's operating modes.

The field team consists of a Senior Technician and an Engineer from the Systems Assessment Team at Fort Belvoir. A Field Monitor from a COBRO Corporation field office and the COBRO Senior Technical Analyst for the TAP SDC Program at Fort Belvoir completes the team.

At the field site the team accomplishes the following:

Assistance of the system operator(s) is solicited to identify the separate power consuming subsystems/components of the system housed in the shelter. The inventory data are posted to the Power Using Inventory form (Figure 1).

The interrelationships and power supply lash-up is reviewed as a basis for developing the measurement test plan. Initially the plan is tentative and can be sensitive to the unexpected. The plan is modified as necessary and posted to the Power Measurement Load Configuration form (Figure 2) as a sequence of power-up events. Measured results of the power-up sequences are posted by input power phase (A,B, and C) to the Power Generator Performance Data form (Fig 3).

Notes about shelter size, trailer information, prime movers, generators, and air conditioners are taken. Operators and crew members are debriefed to gain insight to operating modes, operating conditions, training, and field experiences. Debriefings are based on the format presented in Figure 4.

The team reviews the information gathered and conducts a verification analysis to insure values of voltage, current, and wattage can be determined for each component on the inventory; either measured directly or calculated from other measured values.

POWER ANALYSIS

Values recorded on the Power Generator Performance Data Form are verified by the Systems Assessment Team at Fort Belvoir using procedures calculated to establish the power values to be used later in Fort Belvoir's Shelter Systems Assessment Model (SAM).

SAM is utilized to determine cooling requirements that maintain Human Engineering habitability conditions (MIL-STD-1472) at various climate conditions.

DAS3 DESCRIPTION

The DAS3 (Decentralized Automated Service Support System) is used at division and corps to perform automatic data processing functions. The system accomplishes data reduction, data manipulation and summarization, generation of reports and historical files, processing of transactions of an interactive or batch basis, and has the capability to interface, electronically or through the use of some recording media, with other levels of management information systems.

DAS3 POWER USING EQUIPMENT INVENTORY

The DAS3 (D/C)(AN/MYQ-4A) is based on the DAS3 field system, AN/MYQ-4. The AN/MYQ-4A includes additional automatic data processing equipment (ADPE) to facilitate support at division and corps headquarters.

The DAS3 assessed is housed in an XM971, mobile van. At the time of inventory the system was parked on hardstand and cabled for power to a commercial, 120 VAC, disconnect. The generator assigned to support the system in the field is the 60KW, PU-650B/G (MEP-006A). Environmental control is provided by four, front-mounted, vertical, 18K BTU, 208 VAC, 60Hz air conditioners.

At the time of inventory one air conditioner was disinstalled for maintenance action. One of the three installed in the van was not working. The system was being deprocessed for turn-in. As a consequence, the mass storage disk system and the magnetic tape system were not operational. The humidifier was also non-operational.

POWER CONSUMING EQUIPMENT

System Code	Line Number	Nomenclature	Model	Stock Number
BD044	D78325	System, Auto Data Proc	AN/MYQ-4A	7010-01-158-5397
BD045	None	Unit, Data Processing	CP-1435	5895-01-092-2549
BD046	None	Unit, Magnetic Tape	TW-430	5895-01-092-2550
BD047	None	Printer, Line	RP-309	7010-01-177-0646
BD048	None	Unit, Disk Memory	MV-705	7025-01-092-2745
BD049	None	Cleaner, Magnetic	MX-10172	7045-01-016-4147
BD050	None	Card, Punch, Reader I	R-0526A	5999-01-092-2551
BD051	None	Display, Keyboard	MX-10173	5895-01-092-2552
BD052	None	Drive, Dual Diskette	MV-857	None available
BD053	None	Humidifier	6066N10	None available
BD054	None	Heater, Space, Electric	H-52641	4520-00-177-6198
BD055	None	Assembly ssembly	TT-804	6675-01-153-0775
BD056	None	Converter, Frequency	CV-3661A	5895-01-092-2649
AA006	None	Light, Flourescent, ICP	BR-2009	None available
AK001	A24455	Conditioner, Air	F 18T-2	4120-01-089-4053
BD057	None	Converter	CV-3787	None available
BD058	None	Modem	MD-1149	None available
BD059	None	Converter	CV-3738	None available
BD060	None	Modem	MD-1150	None available
BD061	None	Unit, Isolator	None	None available

DEBRIEFING

An operator was debriefed on DAS3 operational modes and areas of interest about the environmental control system. The information provided by the briefee, in response to questions asked, follows:

Demographics

Briefee	System operator
Military Occupational Specialty	76PM6 DAS3 skill identifier
Training	DAS3 Course, Fort Lee, 1989
Time on DAS3	Approximately 4 years
Field exposure during DAS3 assignment	Five training exercises

Modes of Operation

What are the DAS3's modes	Standby - System up, no proc Operating - Job processing
Number of operators required	One - Minimum jobs Three - Moderate number jobs Four - Maximum jobs simultaneously
Define minimum operation	Administrative procedures filing, labelling
Define moderate operation	One job at a time
Define maximum operation	Processing one job, preparing for others under time constraints
Duration of maximum operation	Three to five days
Longest required duration	As required
Modes you have operated	All three
Status of shelter door	Closed during operation

NBC

Collective protection for NBC	No

Environmental Control

Shelter has ECU	Yes
ECU nomenclature	Vert A/C, 60Hz, 208VAC, 3Ph
Model	F 18T-2
Heating	13,000 BTU
Cooling	18,000 BTU
How often ECU used	Full time
Comfort during hot weather	Reasonable
Comfort during cold weather	Reasonable
Proper operating temperatures	Yes, with all four ECUs
Proper operating temperatures (Cold)	Adequate
Operation of ECU unit	Easy
Your problems with ECU	No indicators of freon leak Noisy
Maintenance	Adequate - Had priority
Other comments pertinent	A/C output not adequately distributed

SYSTEMS INVENTORY FORM

1. Control Number	2. Line Number	3. NSN	4. Nomenclature	5. Model	6. Prime Mover/Model	7. System Gen. Code	8. KW	9. Type Shelter	10. Weight
FU00504									

11. Reference Document	12. Manufacturer	13. Frequency (HZ)				14. Voltage							15. Phase				16. Number Operators	17. Source Of Values				18. Date
		DC	50	60	400	28	110	120	208	220	240	416	Single	3PH	DC	Other						

SUB SYSTEM

19. System Code	20. Line Number	21. Nomenclature	22. Model	23. NSN	24. Required			25. Type Voltage		26. System BTU		27. Value Source				28. Qty	29. Remarks
					Volts	Amps	Watts	AC	DC	Heating	Cooling	M	C	S	T		

Figure 1. System Inventory Form

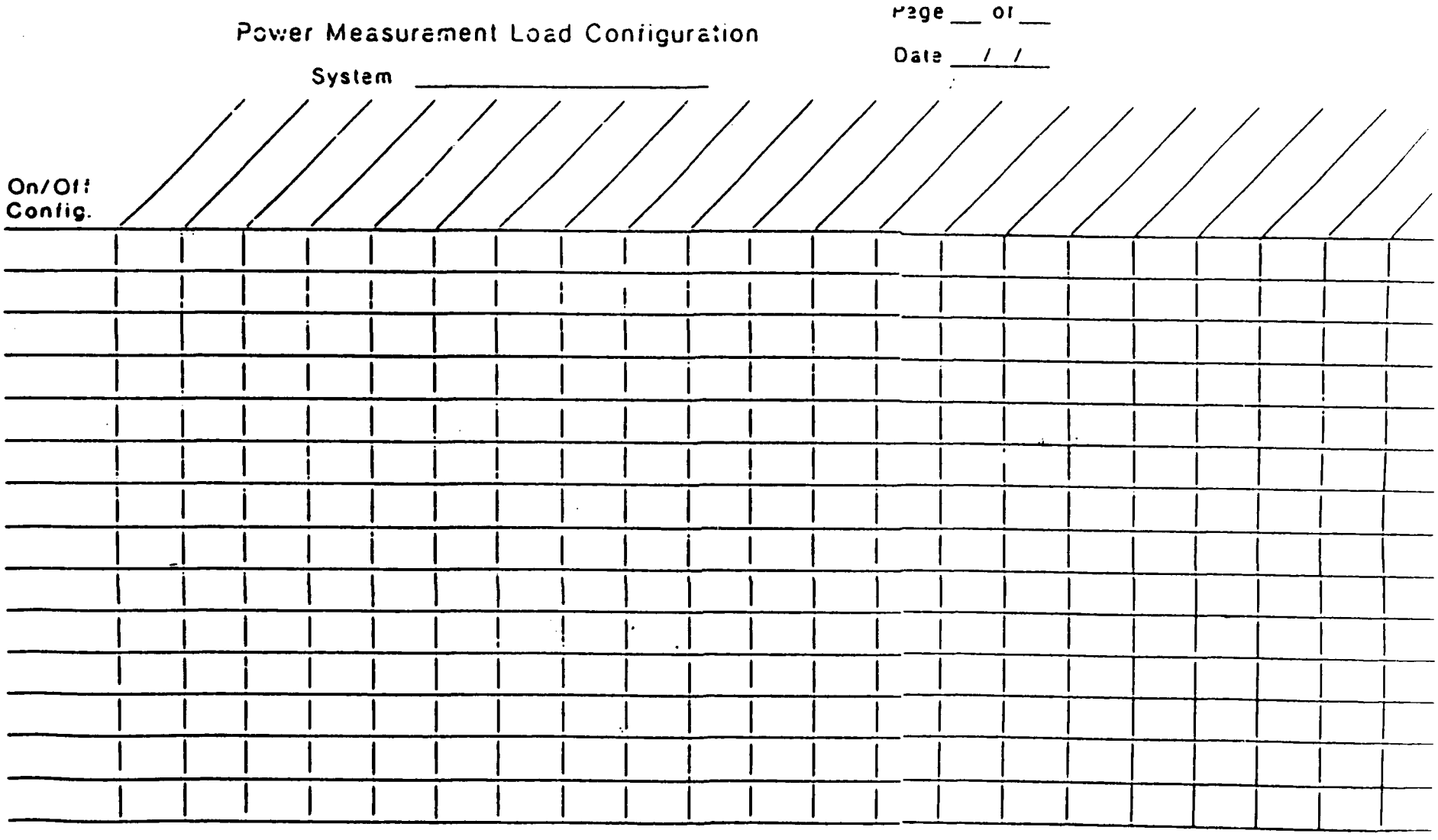

Figure 2. Power Measurement Load Configuration

Power Generator Performance Data

Date / /

System _____

On/Off Config.	Phase A				Phase B				Phase C			
	V	A	W	PF	V	A	W	PF	V	A	W	PF

Figure 3. Power Generator Performance Data

Air Conditioner Requirements Review

INTRODUCTION

The information in this completed debriefing is supplemental to and becomes part of the unbundled system data file.

The data for this portion of the Air Conditioner Requirements Review will be obtained by a member of the TAP program Unbundling Team during an informal discussion with an assigned operator of the unbundled system. The following sections should be used to guide the discussion.

SYSTEM DESCRIPTION

1. Date: _____

2. System Unbundled: _____

3. Location: _____

4. Site Description: _____

_____

SYSTEM POWER REQUIREMENTS

5. What Type of Power Does the System Require? ____60Hz; ____DC;

____400Hz; Single Phase? ____120v; ____240v; Three Phase?

____208v; ____416v?

6. For DC Systems, What Equipment Requires the DC Power? _____

_____

7. For 400Hz Systems, What Equipment Requires the 400Hz Power? _____

_____

DEMOGRAPHICS

8. **Briefer:** _____

9. **Briefee:** _____ **MOS:** _____

10. **Training:** ____ **School** ____ **OJT** ____ **When?** _____

11. **Length of Assignment to System: Years** _____ **Months** _____

12. **Field Exposure While Assigned:** _____

Figure 4. Debriefing Format

_____

_____

MODES OF OPERATION

13. What are the System's Mode(s) of Operation?

_____

_____

14. How Many Operators Required For Each Mode?

15. Low _____

16. Moderate _____

17. High _____

18. Your Understanding of Low Intensity Operation. _____

_____

_____

19. Your Understanding of Mid Intensity Operation. _____

_____

_____

20. Your Understanding of High Intensity Operation. _____

_____

_____

21. What Is the Expected Duration for High Intensity Operation? _____

_____

_____

22. What Is the Longest Required Duration for High Intensity Operation

_____

_____

Figure 4. Debriefing Format (Continued)

23. Which of the Three Operational Levels Have You Operated the System? ____ Low ____ Mid ____ High

24. Do You Normally Operate the System With the Shelter Door Open ____ Or Closed ____?

NBC

25. Is the Shelter Equipped with Collective Protection for NBC (CBR) conditions? ____

26. How Well Does the Collective Protection System Work? _____

_____

_____

ENVIRONMENTAL CONTROL UNIT

27. Does the Shelter Have An ECU? ____ Yes ____ No

28. ECU Nomenclature: _____

29. Model: _____

30. Heating: _____ BTU

31. Cooling: _____ BTU

32. How Often Do You Use the ECU? _____

_____

33. What Is Your Assessment Of the Interior Comfort When Your System Is Being Operated For Extended Periods During Hot Weather? _____

_____

34. What Is Your Assessment Of the Comfort When Your System Is Being Operated For Extended Periods During Cold Weather? _____

_____

_____

Figure 4. Debriefing Format (Continued)

35. Do You Think the ECU Adequately Maintains Proper Equipment Operating Temperatures?

36. During Hot Weather? _____

37. During Cold Weather? _____

38. How Would You Categorize Operation (Operator Interface) Of the ECU?

39. Easy ____

40. Difficult ____

41. Complex ____

42. What Problems Have You Experienced With the ECU? _____

43. 1. _____

44. 2. _____

45. 3. _____

46. What Other Comments Regarding the System, Its operation, Air Conditioning, Heating, Or Collective (NBC/CBR) Protection Would You Like To Note? _____

Figure 4. Debriefing Format (Continued)

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